Aim: To standardize management of patients with empyema.

Patient with signs/symptoms of empyema:
- Fever, cough, increased WOB (See Note 1)
- Effusion seen on CXR
- Diagnosed with Pneumonia and clinical worsening on appropriate therapy (see Pneumonia Guideline)

Initial Assessment
- Assess for sepsis (See Note 2)
- Pulse-oximeter, start supplemental oxygen if O2 sats < 90%
- Consider high flow nasal cannula if increased WOB.
- Place PIV, provide IVF, analgesia/anti-pyretics
- Obtain initial labs (BEFORE antibiotics): CBC w/differential, CMP, CRP, blood culture, nasal MRSA PCR
- COVID/influenza testing if indicated.

Obtain Imaging
- AP/Lateral decubitus CXR
- Ultrasound chest if suspecting moderate-large effusion (see Note 3)
- CT scans not routinely indicated

Significant effusion unlikely
- Return to Community Acquired Pneumonia Guideline
- Consider ID/Pulmonary consult
- Consider re-imaging if no improvement in 24–48 hours

Effusion > 1 cm and occupies > ¼ of hemithorax or compromises breathing?

Significant effusion, empyema is possible.
- NPO with IVF
- Provide analgesia
- Educate caregivers about empyema (see Note 4)
- Order appropriate antibiotics (see Page 3)

Admit to PICU/IMC for chest tube placement and management.
- Obtain consent for chest tube
- Plan deep sedation
- Place chest tube: size 8–12 Fr
- Consider PICC or central line placement
- Consider NG placement for nutrition support
- Send pleural fluid in capped syringe for cell count, gram stain, culture (aerobic and anaerobic) and save sample (≥ 1 mL frozen) for further testing (including 16s [bacteria] and 18s [fungi] rRNA PCR). Order the aerobic culture as “body fluid.”
- Consult Pulmonary
- Consult Infectious Disease if concern about staphylococcal infection, infection due to unknown or unusual organism (e.g. anaerobes, gram-negative, Mycobacteria, necrotizing pneumonia or lung abscess), or failure to improve

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**PNEUMONIA COMPLICATED BY EMPYEMA: ONGOING MANAGEMENT**

(Age 3 months–24 years)

**Aim:** To standardize management of patients with empyema.

**EXCLUSION GUIDELINES**

Patients excluded from this guideline:
- Immunodeficiency, sickle cell disease, CF, tracheostomy, or neurological impairment
- NICU patient
- Hospital-acquired or postprocedural empyema

**Patient with Empyema, s/p Chest Tube placement**
- Obtain CXR to confirm tube position
- IV/PO acetaminophen
- IV ketorolac/PO ibuprofen if renal function adequate
- Consider hydromorphone PCA
- Continue empiric antibiotics (see Page 3)
- Consider NG feedings (see Note 5)
- Bowel regimen
- Pulmonary and child life consult

**Begin intrapleural tPA**
- Pt < 10 kg: Give 4 mg tPA dissolved in 10 ml NS then a 5 ml NS flush
- Pt ≥ 10 kg: Give 4 mg tPA dissolved in 20 ml NS then a 5 ml NS flush
- Continue tPA once daily x 3 days
- Consider intrapleural DNase (in addition to tPA) if pleural WBC > 10,000 (see Note 6)

**Repeating labs/imaging**
- Repeat Hgb and CRP every other day. BMP and albumin daily if primarily on IVF, otherwise every other day. (See Note 7)
- Repeat CXR daily while chest tube is present

**Assess need for vancomycin daily**

**All of the following present?**
- < 10–15 ml of chest tube output per 24 hours
- Improved effusion on CXR
- Improved fever curve, CRP, oxygen needs, and PO intake

**Discharge Criteria**
- Tolerating consistent PO
- On room air
- Improving fever curve
- Improving CRP
- Caregivers comfortable with follow-up
- PCP f/u in 2–4 days
- Pulmonary f/u 1 week via telehealth and 3 months in person w/ CXR
- Antibiotic course: 14–21 days after pleural fluid drainage (21–28 days if staphylococcal)

**Remove chest tube**
- Tube to be removed by PICU team
- Repeat CXR after removal to assess for pneumothorax

**Start oral antibiotics (see Note 8) when:**
- Tolerating PO, chest tube removed, and culture results and sensitivities are known

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Initial IV antibiotics:
Ceftriaxone 50 mg/kg q12h (max: 2,000 mg/dose)*
If severe cephalosporin allergy:
Levofloxacin
- 6 mo to < 5 years: 10 mg/kg/dose IV q12h (max 375 mg/dose)
- ≥ 5 years: 10 mg/kg/dose IV q24h (max 750 mg/dose)

Add Vancomycin 15 mg/kg q6h if < 18 years old or 15–20 mg/kg q12h if 18–24 years old (trough goal 15–20 mg/L)

Hypotension or requiring vasopressors OR
Prior respiratory isolation of MRSA OR
Hospitalization & IV antibiotics within 90 days OR
Influenza positive

Do not add vancomycin

Positive Nasal MRSA PCR
- Yes
  - Consider discontinuing vancomycin if cultures negative for MRSA

- No
  - Consider discontinuing vancomycin if patient improving within 24–48 hours

Assess need for MRSA coverage based on cultures and clinical response to current regimen

Transition to oral antibiotics (see Note 8) when:
Tolerating PO, chest tube removed, and cultures and sensitivities known
Options based on tolerance, cultures, and allergies:
- Amoxicillin 30 mg/kg/dose PO TID (max 1250 mg/dose)
- Cephalexin 25 mg/kg/dose PO TID (max 1250 mg/dose)
- Amoxicillin/clavulanate 45 mg amoxicillin/kg/dose PO BID (max 2000 mg amoxicillin/dose) (use 14:1 formulation)
- Cefdinir 7 mg/kg/dose PO BID (max 300 mg/dose)
- Clindamycin 10 mg/kg PO TID (max 600 mg/dose)
- Cephalosporin allergy: Levofloxacin 10 mg/kg/dose PO BID if 6 months to < 5 years (max 375 mg/dose); 10 mg/kg/dose PO daily if ≥5 years (max 750 mg/dose)

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NOTE 1. Signs/symptoms of complicated pneumonia include: Cough, fever, increased work of breathing, crackles on lung exam. Differential diagnosis includes: CHF, foreign body, pertussis, measles, TB, aspiration, empyema/abscess, fungal/viral infection, atypical pneumonia, bronchiolitis/viral pneumonia, inhalation injury, asthma, lung malformation. Organisms commonly involved in empyema include: Streptococcus pneumoniae, Streptococcus pyogenes (GABHS), Streptococcus viridans and Staphylococcus aureus (MRSA and MSSA).

NOTE 2. Sepsis. Patients with bacterial infections such as pneumonia/empyema are at increased risk for SIRS (systemic inflammatory response syndrome) or sepsis, as well as respiratory failure (e.g. high work of breathing, retractions, nasal flaring, head bobbing, tachypnea).

SIRS: > 1 of (must include either temp/WBC):
- Temp > 38.5 (> 38 if < 2 mo age) or < 36
- Tachycardia (or bradycardia if < 1 yr age)
- Tachypnea
- WBC < 5,000 or > 15,000 or > 10% bands

Sepsis: SIRS + suspected infection

Severe Sepsis: Sepsis + CV dysfunction or ARDS or 2+ organ dysfunctions

Septic Shock: Sepsis + CV dysfunction that persists after ≥ 40 mL/kg NS in one hour

NOTE 3. Effusion sizing. Effusions < 10 mm, or < ¼ hemithorax are considered mild. Moderate or large effusions are > 10 mm and occupies ½ of the hemithorax or if they compromise breathing.

NOTE 4. Caregiver education. Empyema is defined as pneumonia that has extended beyond the surface of the lung to infect the space and lining of the inside of the chest wall. Patient with empyema have a 10–20% chance of failing medical therapy (antibiotics + chest tube + intrapleural medications) and may require a VATS (video-assisted thorascopic surgery) procedure to remove infectious debris from inside the chest. Average hospital length of stay for patients with empyema is 9 days. Children who experience an empyema are not typically prone to future lung infections and are expected to have normal lung function after appropriate recovery.

NOTE 5. Nutrition. Patients with empyema are at risk for malnutrition due to poor oral intake during illness and ongoing protein losses. Consider NG placement for early enteral nutrition support. Provide bowel regimen (e.g. polyethylene glycol and senna) to prevent constipation in setting of inactivity and opioid medications.

NOTE 6. Intrapleural DNase is generally not recommended. An RCT found no differences in outcomes in patients treated with both tPA plus DNase compared with tPA plus placebo (Livingston et. al. JAMA Pediatrics 2020). Consider in patients with a pleural WBC of > 10,000. DNase 5 mg is dissolved in 10 ml NS for patients < 10 kg and 20 ml NS for patients ≥ 10 kg and followed by 5 ml NS. DNase is administered at least 2 hrs after tPA. DNase is never used as the sole intrapleural agent.

NOTE 7. Lab notes. Close attention must be paid to fluid balance and sodium as patient with empyema are at risk for SIADH (syndrome of inappropriate antidiuretic hormone secretion). Albumin may become very low in patients with empyema (< 2.0) due to leakage of proteins into the pleural space and has been identified as a predictive risk factor for empyema in patients suspected of having pneumonia (Chalmers et. al. 2009).

NOTE 8. Antibiotic notes. A comparative effectiveness study, using propensity score-weighted regression, found no difference in outcomes between patients discharged on oral antibiotics compared with those discharged with IV (e.g. PICC) antibiotics (Stockmann et.al. 2015). A multicenter cohort study of 2123 children with parapneumonic effusion and empyema had similar findings (Shah et.al. 2016). Duration of antibiotic therapy is influenced by the organism, adequacy of source control, and clinical response. For non-staphylococcal disease, typical antibiotic course is 14–21 days after pleural fluid drainage. Staphylococcal disease may require therapy for 3–4 weeks. Choose the narrowest appropriate oral antibiotic based on susceptibility results (e.g. amoxicillin for Streptococcus pneumoniae or Streptococcus pyogenes).
Aim: To standardize management of patients with empyema.

### Key Outcome Measures
- Proportion of patients evaluated for empyema with chest ultrasound vs. chest CT
- Proportion of patients with negative nasal MRSA PCR and vancomycin discontinued

### Key Balancing Measures
- Length of stay
- Unplanned outpatient visits/readmissions in first 14 days

### References

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REFERENCES (continued)


Empyema workgroup: Mikkelsen, Koutsari, Pomputius, Hester